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## PART I - ADMINISTRATIVE

### Section 1. General administrative information

#### Title of project

Monitor, Evaluate, And Research The Lake Roosevelt Fishery

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**BPA project number:** 9404300

**Contract renewal date (mm/yyyy):** 4/1999 ☐ **Multiple actions?**

**Business name of agency, institution or organization requesting funding**

Spokane Tribe of Indians

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**Business acronym (if appropriate)** STI

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#### NPPC Program Measure Number(s) which this project addresses

Primary measure 10.8B.5; supporting measures 2.2E5 - 2.2E.7, 10.1, 10.3E.3, 10.3E.5, 10.8A, and 10.8B.2 - 10.8B.4

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#### FWS/NMFS Biological Opinion Number(s) which this project addresses

Task No. 2.1.d of the NMFS Proposed Recovery Plan for Snake River Salmon; "Conduct monitoring, evaluation and research to support flow augmentation efforts."

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#### Other planning document references

Upper Columbia Blocked Area Management Plan.

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#### Short description

Monitor and evaluate the performance of hatchery fish. Develop and maintain a model able to predict the effects of hydro-operations and management actions on the lake ecosystem and fishery. Use model results to refine a fisheries management plans.

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#### Target species

Indigenous and non-indigenous: kokanee salmon, redband trout, rainbow trout, burbot, white sturgeon, walleye, smallmouth bass, yellow perch, mountain whitefish, lake whitefish, catostomid spp., cyprinid spp., centrarchid spp. and cottid spp.

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## Section 2. Sorting and evaluation

### Subbasin

Upper Columbia Mainstem, San Poil, Colville, Kettle and Spokane

### ***Evaluation Process Sort***

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
<input type="checkbox"/> Anadromous fish <input checked="" type="checkbox"/> Resident fish <input type="checkbox"/> Wildlife	<input checked="" type="checkbox"/> Multi-year (milestone-based evaluation) <input type="checkbox"/> Watershed project evaluation	<input type="checkbox"/> Watershed councils/model watersheds <input type="checkbox"/> Information dissemination <input type="checkbox"/> Operation & maintenance <input type="checkbox"/> New construction <input checked="" type="checkbox"/> Research & monitoring <input checked="" type="checkbox"/> Implementation & management <input type="checkbox"/> Wildlife habitat acquisitions

## Section 3. Relationships to other Bonneville projects

***Umbrella / sub-proposal relationships.*** List umbrella project first.

Project #	Project title/description

### ***Other dependent or critically-related projects***

Project #	Project title/description	Nature of relationship
9104600	Spokane Tribal Hatchery	Releases hatchery reared kokanee and rainbow trout into Lake Roosevelt. The proposed project herein monitors and evaluates hatchery fish performance and their ecological impacts.
9104700	Sherman Creek Hatchery	Releases hatchery reared kokanee and rainbow trout into Lake Roosevelt. The proposed project herein monitors and evaluates hatchery fish performance and their ecological impacts.

9500900	Lake Roosevelt Rainbow Trout Net Pens	Releases hatchery reared kokanee and rainbow trout into Lake Roosevelt. The proposed project herein monitors and evaluates hatchery fish performance and the ecological impacts from fish and in situ net pens.
9001800	Habitat Improvement Project	Supplies data on adfluvial redband and rainbow trout populations residing in tributaries draining into Lake Roosevelt. This information is vital for model and management plan completion.
9501100	Chief Joseph Kokanee Enhancement Project	Provide estimates of fish entrainment through Grand Coulee Dam, estimates number of tributary spawning kokanee, and determines if Lake Roosevelt contains a genetically unique stock of kokanee. This data is vital for model and management plan completion.
9700400	Resident Fish Stock Status Above Chief Joseph and Grand Coulee Dams	Provides a clearinghouse of organized fisheries related databases to facilitate management planning.
9502700	Lake Roosevelt Sturgeon Project	Provides sturgeon data for modeling and management planning efforts.
8810804	Streamnet	Provides regional information vital to model development.
9094	Lake Roosevelt Kokanee Net Pens	Releases hatchery reared kokanee into Lake Roosevelt. The proposed project herein monitors and evaluates hatchery fish performance and their ecological impacts.
	Phalon Lake Redband Trout Trapping Facility	Provides an alternate source of trout for stocking programs in Lake Roosevelt, which will be evaluated by the Lake Roosevelt Monitoring Program.
	Ford Hatchery Water Supply Improvement	Provides additional rearing space for fish releases into Lake Roosevelt and Banks Lake, which will be evaluated by the Lake Roosevelt Monitoring Program.
	Little Falls Kokanee Egg Collection and Acclimation Facility	Collects adult kokanee spawners for egg collection and acclimates yearling kokanee prior to stocking

		into the Spokane arm of the lake.
	Lake Roosevelt Forum	Provides a forum that facilitates roundtable discussion among managers and other stakeholders on topics such as hydro operations and fisheries issues.
	Lake Roosevelt Water Quality Council	Provides peer review for the Lake Roosevelt Monitoring Program and conducts supporting research such as fish heavy metal and organic toxin loads in fish tissues.

## Section 4. Objectives, tasks and schedules

### *Past accomplishments*

Year	Accomplishment	Met biological objectives?
1988	From 1988 to date, The Lake Roosevelt Monitoring Program (this project) began collecting baseline limnological, biological and fisheries data.	First BPA funded project to collect information on Lake Roosevelt so that informed biological objectives could be developed.
1988	Under the auspices of the Lake Roosevelt Monitoring Program, established coordinated Fisheries Co-Managers of Lake Roosevelt among WDFW, CCT and STI.	This is the first project where Lake Roosevelt Fisheries Co-Managers were funded to collectively participate in the monitoring, evaluation and development of mutually agree upon fisheries goals and objectives.
1988	Established communication with local and regional Columbia River stakeholders through special interest groups (i.e. CBFWA, NWPPC, Lake Roosevelt Forum) which continues to date.	Continual communication is helping to create a mutually agreed upon fisheries resource expectation for Lake Roosevelt among directly and indirectly affected stakeholders.
1990	Established hatchery reared kokanee and rainbow trout stocking goals based on food (zooplankton) availability. Set harvest goals based on stocking goals.	First Lake Roosevelt Biological Objectives.
1990	Established new walleye harvest regulations to maintain a harvestable population.	Increased the number and size of walleye harvested in subsequent years.
1991	Spokane Tribal Hatchery began operation (managed by Spokane Tribe of Indians)	First hatchery with the primary purpose of providing kokanee and rainbow trout for Lake Roosevelt.
1991	Annually monitor and evaluate the performance of fish from the hatcheries	Hatchery stocking strategies are adjusted annually to maximize

		angler harvest and minimize impacts to wild native species.
1992	Sherman Creek Hatchery began operation (managed by Washington Department of Fish and Wildlife)	First year Spokane Tribal Hatchery kokanee are transferred to Sherman Creek Hatchery for the final three months prior to release. Also, first year Sherman Creek operated the kokanee egg collection facility.
1992	Established time frame when kokanee are physiologically predisposed to forming an olfactory imprinted memory of the water, which they are reared in.	Indicates that olfactory imprinting can be used as a means to enhance the return of kokanee to Sherman Cr. Hatchery by exposing kokanee to a unique scent at the Spokane Tribal Hatchery and then releasing the same scent at Sherman Cr. during spawning.
1992	Discovered that kokanee exhibit weak smoltification characteristics, both physiologically and behaviorally, during their first year of life.	Smolted kokanee exhibited down stream migration behavior during April - May coinciding with the spring drawdown, leading us to believe that entrainment is a limiting factor and began testing the performance of yearling post-smolts in the lake.
1993	Surveyed the benthic macroinvertebrate community and estimated terrestrial macroinvertebrate deposition.	Affirmed our hypothesis that Lake Roosevelt food web is primarily driven by pelagic organisms with minimal benthic and terrestrial macroinvertebrate contributions supporting our objective to enhance pelagic oriented fish species.
1993	Established a relationship between water retention time and zooplankton production.	Discovered the need to keep the water retention time greater than 30 days to maximize zooplankton density and biomass.
1994	Participated in human health studies which investigated toxin loads (ie. mercury, PCBs, dioxins and furans) in tissue of walleye, rainbow trout, kokanee and whitefish. Also, conducted surveys to estimate Lake Roosevelt fish consumption by anglers.	Identified minimal health risks for those eating Lake Roosevelt walleye, whitefish, kokanee, and rainbow trout.
1994	Imprint kokanee to a unique scent while being reared at the Spokane Tribal Hatchery, then released the same scent at Sherman Cr. during the kokanee	The first year adult spawning kokanee returned to Sherman Cr. as a result of imprinting. This was the beginning of a self-sustained Lake

	spawning migration to increase the number of kokanee returning for egg collection to Sherman Cr.	Roosevelt kokanee egg source.
1994	Hatcheries changed kokanee stocking strategies by moving from fry to yearling releases.	Fry kokanee releases resulted in less than one percent conversion to either harvest or adult spawner returns. Yearling releases have performed 5-10 times greater than fry, moving us closer towards our biological objectives.
1994	Changed stocking period of net pen and hatchery reared rainbow trout from April to June.	By releasing rainbow trout after the spring freshet, entrainment was minimized, growth increased and harvest increased exponentially.
1994	Changed stocking period of hatchery reared kokanee from May to July.	By releasing kokanee after the spring freshet, entrainment was minimized. As a result, adult kokanee returns to egg collection facilities and recruitment to angler harvest has increased dramatically.
1994	Established the need to model the effects of hydro-operations and management actions on the ecosystem and fishery of Lake Roosevelt in the NWPPC Program, in order to create harmonized management objectives between lower and upper river stakeholders.	The overwhelming complexity of the Lake Roosevelt ecosystem limits our ability to adequately manage the fishery. The modeling exercise seeks to package this complex ecosystem into understandable outputs and facilitate informed management.
1995	Established interim Lake Roosevelt hydro-operations rule curves in NWPPC Program	Rule curves were created to facilitate ecosystem productivity and fisheries production.
1995	Became member of the TMT to participate with in-season hydro-operations decisions.	Hydro-operation decisions affect entrainment rates of resident fishes and the overall productivity of the lake. Our involvement has limited hydro-operation impacts to Lake Roosevelt while considering other stakeholder needs.
1997	Intensified data collection to a level appropriate for modeling the effects of hydro-operations and potential management actions on the ecosystem and fishery of Lake Roosevelt.	This activity is expected to enhance lake manager's ability to reach biological objectives through educated decision making.
1998	In cooperation with the Sturgeon Project (BPA Project No.8605000) indexed the Lake Roosevelt sturgeon population.	Sturgeon age class structure suggests an extremely suppressed population with virtually no recruitment over

		the last 20-25 years.
1998	Imposed new kokanee harvest regulations limiting angler harvest to hatchery fish only.	Over the short term, has decreased the number of harvestable kokanee in the lake, but will theoretically increase the survival of wild kokanee allowing for greater natural escapement.

### ***Objectives and tasks***

<b>Obj 1,2,3</b>	<b>Objective</b>	<b>Task a,b,c</b>	<b>Task</b>
1	Monitor and evaluate impacts of hatchery origin fish on wild fish and lower trophic levels of the Lake Roosevelt ecosystem.	a	Conduct fishery surveys through electro-fishing, gillnetting and beach seining three times a year at eleven stations in the reservoir to assess wild and hatchery fish abundance, feeding habits, habitat use, growth and age structure.
		b	Procure and compile into a master data set current and historical data from other projects conducted on Lake Roosevelt and its tributaries.
		c	Monitor and evaluate the effects of fish net pens on the ecology of Lake Roosevelt through periphyton, total organic carbon, macroinvertebrate and fish community studies.
		d	Evaluate realized and potential competitive interactions between hatchery and wild fishes.
		e	Recommend stocking strategies and management actions which minimize negative interactions among hatchery and wild fish and recommend rearing methods which minimize negative impact to the environment.
2	Monitor and evaluate the performance of hatchery fish in the Lake Roosevelt fishery	a	Conduct Lake Roosevelt creel surveys.
		b	Estimate angle pressure, harvest and catch for all predominant fisheries.
		c	Evaluate hatchery versus wild fish performance in fishery.
		d	Mark hatchery origin rainbow trout

			and kokanee with anchor tags by release group.
		e	Describe performance of marked release groups in the fishery.
		f	Evaluate harvest biological objectives in terms of progress towards objectives and objective attainability.
		g	Recommend hatchery operations and management actions (e.g. harvest regulations) which maximize hatchery fish harvest and minimize wild fish harvest.
3	Monitor and evaluate the performance of hatchery fish in the Banks Lake Fishery (This task will be completed if the Ford Hatchery Project does not receive funding).	a	Conduct Banks Lake creel survey.
		b	Estimate angler pressure, harvest and catch for all predominant fisheries.
		c	Describe performance of special marked hatchery groups in the fishery.
		d	Evaluate harvest biological objectives in terms of progress towards objectives and objective attainability.
		e	Recommend hatchery operations and management actions (e.g. harvest regulations) which maximize hatchery fish harvest and minimize wild fish harvest.
4	Establish, monitor and evaluate self-sustaining Lake Roosevelt kokanee egg supply.	a	Coded Wire Tag hatchery release groups to determine which groups most successfully return to egg collection facilities.
		b	Expose Spokane Tribal Hatchery kokanee to a unique scent during imprinting stage by dripping metered concentrations of morpholine into the hatchery water system. Subsequently, drip unique scent into the Sherman Cr. fish trap during the spawning migration.
		c	Identify, pursue and test through

			marking studies the use of indigenous kokanee stocks such as Kootenay and Arrow Lakes Stocks.
		d	Use electrofishing and trapping to collect viable eggs from returning adult kokanee spawners.
		e	Extract coded wire tags from spawned kokanee to estimate release group return and stray rates.
		f	Recommend hatchery release strategies and management actions which maximize the return of kokanee to egg collection facilities
5	Maintain current databases and continue testing of ecological relationships in order to validate, refine and maintain the environmental model of Lake Roosevelt.	a	Collect water quality data to monitor the temporal-spatial dynamics of physical and chemical water parameters
		b	Verify relationships established in past years among various water quality and hydro-operation parameters through multivariate analyses.
		c	Collect phytoplankton and estimate biovolume by taxon.
		d	Collect primary production rates by carbon 14 methods
		e	Test running hypotheses in regards to water quality parameters and phytoplankton responses
		f	Collect zooplankton data using Wisconsin nets and estimate biomass and density of collected organisms.
		g	Examine zooplankton population structure for changes over time, validate model with collected zooplankton data and test established relationships between phytoplankton and zooplankton.
		h	Monitor macroinvertebrate populations for changes in relationship to hydro-operations.
		i	Estimate population size of pelagic fish species by way of mobile

			hydroacoustics surveys throughout Lake Roosevelt January through November.
		j	Monitor the temporal-spatial distribution of newly released hatchery fish to estimate timing of vulnerability to entrainment and predation.
		k	Combine fixed hydroacoustic data from Grand Coulee Dam (collected by the Chief Joseph kokanee Project) and mobile hydroacoustics to estimate timing and extent of kokanee entrainment.
		l	Monitor habitat use of pelagic fish (i.e. temperature, depth, proximity to lake bottom) by way of mobile hydroacoustics
		m	Monitor littoral habitat use of fish by way of electro-fishing, gillnetting and beach seining. Also, collect species abundance, diet, growth and age information to monitor for ecological shifts.
		n	Collect additional habitat data and apply to GIS Map.
		o	Conduct mark recapture studies during walleye spawning period to estimate spawner abundance and build an index of predator abundance.
		p	Conduct creel surveys to estimate fish harvest. Use creel and age class structure data to estimate mortality rates.
		q	Procure tributary fisheries data to estimate escapement and recruitment of known adfluvial populations.
6	Model of Lake Roosevelt able to predict various tropic level responses to hydro-operation and management actions.	a	Create a Lake Roosevelt specific hydro-operations model on a weekly timestep which is compatible with BPA's system wide hydro model, Hydrosim
		b	Maintain and validate the liminological model CE-Qual.

		c	Maintain and validate the Wisconsin Bioenergetics Model for pelagic species.
		d	Complete the GIS based habitat and fish distribution model.
		e	Create a master model able to link submodels together with appropriate submodel feedback loops using a life cycle model approach.
7	Create a refined Lake Roosevelt Fishery Management Plan	a	Create an idealized long term vision for the Lake Roosevelt fishery and ecosystem using participation of appropriate Columbia River stakeholders.
		b	Run model with various hydro-operation and management action scenarios to identify steps necessary to achieve long term vision.
		c	Identify and evaluate constraints (i.e. economic, biologic, social) limiting our ability to reach the long term vision with participation of appropriate stakeholders.
		d	Adjust vision to match realistic actions based on constraints
		e	Create and publish a document articulating the Lake Roosevelt Fishery Management Plan.
		f	Implement hydro-operation and management actions recommended in management plan.

### ***Objective schedules and costs***

<b>Obj #</b>	<b>Start date mm/yyyy</b>	<b>End date mm/yyyy</b>	<b>Measureable biological objective(s)</b>	<b>Milestone</b>	<b>FY2000 Cost %</b>
1	1/1991	1/2025	Annual escapement goal to exceed:  60,000 wild kokanee with an average weight of 1.5 Lb.  74,000 wild redband/rainbow trout with an average weight	Annually, monitor and evaluate the effects of hatchery stocks on the environment and recommend hydro-operation and management	7.00%

			of 2 Lb.  Walleye, sturgeon, burbot and other species escapement goals yet to be defined.	actions to minimize impacts to wild fish.	
2	1/1991	1/2025	Annual Harvest Goal to exceed:  290,000 hatchery kokanee  120,000 wild kokanee  190,000 net pen reband/rainbow trout  150,000 wild reband/rainbow trout  131,000 wild walleye  Sturgeon, burbot and other species harvest goals yet to be defined.	Annually, monitor and evaluate the performance of hatchery and wild origin fish in the fishery.	7.00%
3	1/2000	1/2025	Yet to be defined.	Annually, monitor and evaluate the performance of hatchery and wild origin fish in the fishery.	3.00%
4	1/1991	1/2025	Annual escapement meet or exceeds 10,000 hatchery origin kokanee at egg collection facilities.	Annually, monitor, evaluate and collect kokanee spawners at egg collection facilities.	10.00%
5	1/1996	1/2003	Provide data sufficient to test existing feasibility of current biological objectives.	Compiled data and identified trophic level relationship sufficient to create a predictive	58.00%

				model.	
6	1/1999	1/2003	Newly defined biological objectives.	Fully developed model able to predict various trophic level responses to hydro and management actions.	10.00%
7	1/2000	1/2003	Achievement of newly defined biological objectives.	Refinement and implementation of the Lake Roosevelt Fish Management Plan.	5.00%
				<b>Total</b>	100.00%

#### **Schedule constraints**

Model must be completed prior to refinement of Lake Roosevelt Fish Management Plan. M&E will not end, but will be curtailed after appropriate M&E plan is identified in the management plan.

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#### **Completion date**

2003 (under current scope this project will downsize in 2003 to conduct primarily monitoring and evaluation with less emphasis on research). M&E will continue indefinitely

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## **Section 5. Budget**

**FY99 project budget (BPA obligated):** \$1,500,000

#### ***FY2000 budget by line item***

<b>Item</b>	<b>Note</b>	<b>% of total</b>	<b>FY2000</b>
Personnel	Project manager, 2.5 biologists, 4 fish techs, 1 office assistant, 1.5 fish taggers	% 17	252,500
Fringe benefits	28% of Salaries	% 5	70,700
Supplies, materials, non-expendable property	40,000 anchor tags, 250,000 CWT plus CWT parts, office, field and laboratory supplies	% 3	48,000
Operations & maintenance	repair, maintenance, utilities, and insurance	% 2	24,000
Capital acquisitions or	hydrolab	% 1	10,000

improvements (e.g. land, buildings, major equip.)			
NEPA costs		%0	0
Construction-related support		%0	0
PIT tags	# of tags: 0	%0	0
Travel	sampling, coordination, public meetings and training	%2	30,000
Indirect costs	21.3% of direct costs less contracted services and capitalized equipment	%6	90,568
Subcontractor	Washington Department of Fish and Wildlife	%26	390,000
Subcontractor	Colville Confederated Tribes	%26	390,000
Subcontractor	Spokane Tribal Laboratory	%0	7,000
Subcontractor	University of Portland - Dr. Wells	%5	80,232
Subcontractor	Eastern Washington University - Dr. Scholz	%6	83,000
Subcontractor	Eastern Washington University - Dr. Soltero	%1	12,000
Subcontractor	Washington State University	%1	12,000
Other		%0	
<b>TOTAL BPA FY2000 BUDGET REQUEST</b>			<b>\$1,500,000</b>

### ***Cost sharing***

<b>Organization</b>	<b>Item or service provided</b>	<b>% total project cost (incl. BPA)</b>	<b>Amount (\$)</b>
Spokane Tribe	Coordination among fisheries co-managers.	%1	10,000
Colville Confederated Tribes	Coordination among fisheries co-managers.	%1	10,000
Chief Joseph Kokanee Project	Grand Coulee Dam Entrainment Study and wild kokanee escapement.	%5	100,000
Redband/Rainbow Trout Habitat Improvement	Tributary carrying capacity and redband/rainbow trout escapement for select tributaries.	%5	100,000
Joint Stock Assessment	Tributary carrying capacity and redband/rainbow trout escapement of select tributaries.	%4	80,000
Spokane Tribe of Indians	Spokane River kokanee trap operation.	%1	10,000

Spokane Tribe of Indians	Spokane Tribal Hatchery mark and release kokanee and rainbow trout into Lake Roosevelt.	%5	100,000
Washington Department of Fisheries	Sherman Creek Hatchery - mark and release kokanee and rainbow trout and capture returning adults.	%3	50,000
Lake Roosevelt Development Association	Lake Roosevelt Net Pens - mark and release rainbow trout and kokanee into Lake Roosevelt.	%1	10,000
Washington Department of Fish and Wildlife	Coordination among fisheries co-managers.	%1	10,000
<b>Total project cost (including BPA portion)</b>			<b>\$1,980,000</b>

### ***Outyear costs***

	<b>FY2001</b>	<b>FY02</b>	<b>FY03</b>	<b>FY04</b>
<b>Total budget</b>	\$900,000	\$750,000	\$750,000	\$600,000

## **Section 6. References**

<b>Watershed?</b>	<b>Reference</b>
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## PART II - NARRATIVE

### Section 7. Abstract

The Lake Roosevelt Monitoring Program (Monitoring Program) addresses the NWPPC's 1994 Fish and Wildlife Program measure 10.8B.5. The Monitoring Program's objectives are: i) monitor and evaluate the impacts of hatchery origin fish on the Lake Roosevelt ecosystem, and recommend stocking strategies that maximize harvest opportunity and egg production while minimizing impacts to wild indigenous fish; ii) create a model which predicts the effects of management actions (i.e. habitat rehabilitation, stocking activities and harvest management) and hydro-operations on the fishery and ecosystem; and iii) develop a Fisheries Management Plan which recommends actions necessary to maximize the Lake Roosevelt fishery while providing for needs of down-stream resources (i.e. fish flows, power and flood control). This program began in 1988 as a hatchery monitoring and evaluation project. However, due to the complexity of Lake Roosevelt and increasing competition among stakeholders for resources vital to the fishery, the Monitoring Program expanded its scope of work to include research and modeling activities in 1997. Unfortunately, because few modeling exercises have been conducted on reservoir ecosystems, literature values for use in model development were unavailable. Thus, data collection and research activities aimed at defining trophic relationships and their limiting factors were undertaken. This knowledge is being incorporated into existing models (Hydrosim, CE-Qual and Wisconsin Bioenergetics) and an innovative umbrella model will be built to incorporate the various sub-model outputs

while allowing for feedback loops among sub-models. With stakeholder input and analysis of constraints, a realistic Fisheries Management Plan will be created and implemented.

## **Section 8. Project description**

### **a. Technical and/or scientific background**

Grand Coulee Dam became functional in 1941, creating Lake Roosevelt. The lack of fish passage over Grand Coulee Dam undeniably caused the extinction of unique anadromous chinook, coho, and sockeye salmon and steelhead trout. Furthermore, changes from lotic to lentic habitat caused the extinction of resident redband, cutthroat, and bull trout (Bryant and Parkhurst 1950; Earnest et al. 1966). The loss of wild indigenous anadromous and resident fishes along with major environmental change resulted in a substantial ecosystem perturbation to the Lake Roosevelt area. This once salmonid based ecosystem became a predominantly cyprinid, centrarchid and catostomid based system, with remnant population of residualized land locked sockeye salmon or kokanee (Gangmark and Fulton 1949).

By the 1960's, fishery surveys indicated an abundant population of kokanee salmon in Lake Roosevelt, with anglers harvesting large numbers from the forebay. Snyder (1967) found kokanee comprising 99% of gill net and purse seine samples, demonstrating favorable ecological conditions for kokanee in Lake Roosevelt at this time. Walleye were planted into Lake Roosevelt during the early 1960's, and were viewed as a beneficial predator capable of regulating kokanee abundance (Snyder 1967).

By the mid to late 1970's, the walleye fishery had gained in popularity, and harvest regulations were implemented (Nelson 1975). Kokanee abundance was declining during this same time period, prompting a review of factors limiting their production. Stober et al. (1977) concluded that the recent decline in kokanee abundance was attributable to the impact of annual drawdown regimes on reproductive success. During this same period, Grand Coulee Dam was retrofitted with a third powerhouse, which went on line in 1975 and doubled the turbine hydro-capacity of the dam. Stober et al. (1977) also evaluated the effect of the third power house on the kokanee population and concluded the pen stocks were positioned to cause significant entrainment of kokanee.

By the early 1980's walleye had become the predominant fishery in Lake Roosevelt (95% of the creel; Harper et al. 1980) while kokanee populations continued to decline. Beckman et al. (1985) examined factors limiting kokanee salmon production, and determined that tributary spawning habitat within the system was insufficient to maintain a viable stock. Beckman et al (1985) also stated that lake operations and resultant water level fluctuations made shoreline spawning futile for kokanee salmon in Lake Roosevelt. Jagielo (1984) addressed the issue of zooplankton as a limiting factor for kokanee, and determined that zooplankton abundance was sufficient to support a much larger kokanee population than existed in Lake Roosevelt. Recent surveys of the Lake Roosevelt

Monitoring Program (LRMP) have shown no change in these findings, with more than ample zooplankton to support kokanee populations.

Factors limiting kokanee production were also thought to affect rainbow trout within the system. Scholz et al. (1986) formulated a restoration plan for the Lake Roosevelt fishery that centered around spawning habitat enhancement and artificial production of kokanee salmon. The management plan also included the following elements: i) maintain existing walleye stocks through natural production and harvest management; ii) enhance natural spawning populations of rainbow trout by improving spawning and rearing habitat, and; iii) conduct a monitoring program designed to evaluate the efficacy of the above measures. This plan was submitted to the Northwest Power Planning Council (NWPPC) and, in 1987, the NWPPC published its Fish and Wildlife Plan (FWP). The FWP directed BPA to fund the construction and operation of two kokanee hatcheries, a rainbow trout habitat improvement project, and a monitoring and evaluation project on Lake Roosevelt. The result was the creation of the Spokane Tribal Hatchery, Sherman Creek Hatchery, the Rainbow Trout Habitat Improvement Project and the Lake Roosevelt Monitoring Program (LRMP).

The Lake Roosevelt Monitoring Program began operations in 1988 to establish baseline data on the ecosystem prior to the implementation of a hatchery program, and to monitor long term effects of the hatchery program on the ecosystem. The Spokane Tribal and Sherman Creek Hatcheries began releasing fish in 1991 and 1992, respectively. The hatcheries initially released up to 1.7 million kokanee fry and 400,000 rainbow trout annually. Initially, the kokanee fishery showed little response to the supplementation program, while the rainbow trout fishery increased substantially.

Physiological and behavior studies conducted under the LRMP showed that kokanee go through a partial smoltification process during their first year of life, making them susceptible to entrainment (Scholz et al. 1993, Tilson et al. 1994 and 1995). Based on these findings, kokanee released from hatcheries as yearlings were anticipated to be less susceptible to entrainment than those released as fry. In 1994, the hatcheries began releasing kokanee as yearlings rather than fry based on recommendations of the LRMP, and the kokanee fishery appeared to respond favorably.

Evaluating benefits directly attributable to changes in release strategies has been complicated by changing hydro-operations and reductions in system productivity since 1994. Since 1994, hydro-operations in Lake Roosevelt have been altered to provide additional flows for anadromous fish migrations in the lower Columbia. These requirements result in an annual late summer drawdown of Lake Roosevelt and cause substantial entrainment of fish from the system (based on data from the Chief Joseph Kokanee Enhancement Project, BPA 9501100). Additionally, nutrient inputs to Lake Roosevelt have declined dramatically since 1994 due to pollution abatement efforts at the Cominco, Ltd. fertilizer plant in Trail, B.C. which discharged approximately 1,200 kg of phosphorous per day in 1994 (Kenyon 1997). Phosphorous loading from this plant was negligible in 1995 and 1996 (Kenyon 1997), and has undoubtedly impacted productivity in Lake Roosevelt.

Additional factors identified as potentially limiting to kokanee production have been examined under the LRMP. Walleye are the primary predator in Lake Roosevelt, and have been shown to feed on kokanee salmon. However, results of diet analyses since 1988 indicate that walleye consume a wide variety of piscivorous prey in Lake Roosevelt and are not heavily reliant upon salmonids. Mysid shrimp have not been identified in Lake Roosevelt since the LRMP began, despite extensive zooplankton surveys, and therefore do not compete with kokanee salmon for food.

#### **b. Rationale and significance to Regional Programs**

Grand Coulee Dam and the impounded waters behind it (Lake Roosevelt), provide many benefits to the region including: hydroelectric power generation, flood control, irrigation water, flows for downstream endangered anadromous fishes and habitat for resident fishes. Unfortunately, competing interests for Lake Roosevelt water coupled with variable precipitation rates, often lead to large seasonal variations in lake elevations resulting in massive disturbances to the lake ecosystem. Recognition of these disturbances has led Lake Roosevelt fisheries managers to argue within regional forums that lake water should be used sparingly and an attempt made to keep pool elevation fluctuations to a minimum. Unfortunately, these managers have been mostly unsuccessful in convincing other interests to keep lake levels stable while satisfying other needs in the basin.

As a result, Lake Roosevelt managers are now attempting to find win-win solutions among the divergent interests of the Columbia River Basin. This will be achieved by incorporating research findings into a reservoir model which will enable this program to predict the effects of hydro-operation scenarios on the various trophic levels of the Lake Roosevelt ecosystem. The model will also account for the effects of management actions on the ecosystem. This model will provide Lake Roosevelt managers with a tool to evaluate hydro-operation scenarios in combination with management actions that will provide a regionally acceptable fishery in Lake Roosevelt while also achieving downstream objectives.

The ultimate product of this program will be the formation of a management plan that has received regional scrutiny through peer and public review and identifies a Lake Roosevelt fisheries vision. Constraint considerations (i.e. economic, social and biological), will be thoroughly analyzed to ensure that the fisheries vision is as realistic as possible. The methods used to achieve this vision will include analysis of a combination of integrated rule curve hydro-operations and various management actions (i.e. hatchery operations). The complexity of the Lake Roosevelt ecosystem precludes the use of simplistic remedies and the rudimentary state of reservoir science necessitates a full modeling exercise rather than relying on literature values. At minimum, this program serves as a focal point for stakeholders of the region to communicate their needs and allow for cooperative decision making to prevail.

**c. Relationships to other projects**

The Lake Roosevelt Monitoring Program (LRMP) is directly related to numerous other BPA and NPPC funded projects within the basin:

<b>Project Number</b>	<b>Relationship</b>
BPA 9104600	Spokane Tribal Hatchery. LRMP relies on the hatchery to conduct necessary marking and imprinting of fish for research needs, and evaluates the effectiveness of hatchery stocking strategies.
BPA 9104700	Sherman Creek Hatchery. LRMP relies on the hatchery to conduct necessary marking and imprinting of fish for research needs, and evaluates the effectiveness of hatchery stocking strategies.
BPA 9500900	Lake Roosevelt Net Pen Program. LRMP relies on the net pen program to assist in fish production to achieve biological objectives, and evaluates the effectiveness of net pen stocking strategies.
BPA 9001800	The Habitat Improvement Project will provide information essential to the development of biological / integrated rule curves.
BPA 9501100	The Chief Joseph Kokanee Enhancement Project will provide information essential to the development of biological / integrated rule curves.
BPA 9502700	The Lake Roosevelt Sturgeon Project will provide information essential to the development of biological / integrated rule curves.
BPA 9700400	The Resident Fish Stock Status above Chief Joseph and Grand Coulee Dams identifies status of stocks and maintains a centralized database for the Upper Columbia River. These two projects are complimentary and rely on each other for pertinent information.
NPPC 10.8B.26	The Native Fish Stock Status will provide information essential to the development of biological / integrated rule curves.

**d. Project history (for ongoing projects)**

The Lake Roosevelt Lake Roosevelt Monitoring Program is the result of a merger between two projects, the Lake Roosevelt Monitoring Program (BPA No. 8806300) and the Lake Roosevelt Data Collection Program (BPA No. 9404300). These projects were merged because each required support staff and data from the other to complete its deliverables.

The Lake Roosevelt Monitoring Program began in July, 1988. The intent of the project was to: i) determine the status of fish stocks in Lake Roosevelt before construction of hatcheries and habitat improvement efforts; ii) Evaluate contributions of habitat improvement projects and hatcheries to the Lake Roosevelt fisheries; iii) recommend hatchery out-planting strategies which maximize harvest of kokanee and rainbow trout and egg collections from kokanee while minimizing impacts to wild populations.

In 1991, the Lake Roosevelt Data Collection Project began operating under the Lake Roosevelt Monitoring Project contract number. The purpose of the Data Collection Project was to assist the resident fish workgroup of the System Operation Review with the development of the EIS. The Project collected data on biotic indices of Lake Roosevelt believed to be effected by lake operations. Those indices included zooplankton density and biomass, water quality and fish growth and entrainment. In 1994, the Data Collection Project was given its own contract and project number.

The two projects combined efforts in 1996 to continue work historically completed under separate contracts and to identify data needs for development of biological and integrated rule curves for Lake Roosevelt as required in the NPPC Fish and Wildlife Program (10.8B.5).

Lake Roosevelt Monitoring Project submitted annual reports to BPA for each year from 1989 through 1995 (Peone et al. 1990; Griffith and Scholz, 1991; Thatcher et al. In Press-a and In Press-b; Underwood and Shields, 1996; Underwood et al., 1996 and 1997), monthly progress reports from May, 1993 through Dec. 1995, and quarterly progress reports from June through December, 1996.

Lake Roosevelt Data Collection Project submitted annual reports to BPA for each year from 1991 through 1995 (Griffith et al. 1995; Griffith and McDowel 1996; Voeller 1996, Shields and Underwood 1996 and 1997), and monthly progress reports from June 1991 through December 1995.

The 1996 annual report for the Lake Roosevelt Monitoring / Data Collection Program (Cichosz et al. 1998) has been submitted to BPA, as were quarterly progress reports in 1996. The 1997 annual report is in progress.

Examples of adaptive management strategies resulting from this project include revisions in hatchery release strategies for kokanee and rainbow trout. Kokanee are now released as post-smolts rather than fry in order to minimize losses due to entrainment and predation, and to maximize harvest potential. Rainbow trout release timings have similarly been altered with beneficial results based on mortality and entrainment studies conducted under this project. In addition, kokanee salmon are chemically imprinted in the hatchery prior to release to maximize returns to egg collection facilities (Scholz et al. 1992 and 1993, Tilson et al. 1994 and 1995).

In 1997, the enhanced Lake Roosevelt Monitoring Program increased data collection efforts substantially to assist in development of an ecosystem based model. Additional efforts were allocated towards further defining the relationships between water quality and production through various trophic levels within the system. Continuation of this additional effort will greatly assist in defining trophic interactions and the effects of hydro-operations and potential management actions on the Lake Roosevelt ecosystem.

**e. Proposal objectives**

### Hypothesis:

- 1) Scientific knowledge will allow for the development of a model capable of predicting various trophic level responses to hypothetical changes in hydro-operations and management actions.
- 2) A fisheries management plan with mitigation actions and hydro-operation recommendations will allow for the establishment of a successful resident fishery while maintaining sufficient flows for downstream water concerns (including salmonid fishery issues).

Assumption(s): Potential exists for substantial numbers of resident fish of high quality to be available for harvest from Lake Roosevelt while simultaneously allowing sufficient water allotment for other concerns (i.e. power production, downstream salmonid issues).

### Biological objectives:

Species	Stock	Harvest Goal	Escapement Goal	Avg. size (lbs.)	Year achieved
Kokanee	Hatchery	290,000	10,000	2.0	2000
Kokanee	Wild (adfluvial)	120,000	60,000	1.5	*
Rainbow Trout	Net pen	190,000	NA	2.0	1997
Rainbow Trout	Wild (adfluvial)	12,000 (interim goal)	6,000	2.0	2000
Rainbow Trout	Wild (adfluvial)	150,000 (final goal)	74,000	2.0	TBD
Walleye	Wild	131,000	Unknown	1.5	1996

\*= Target date will be determined upon completion of baseline investigations, NA=Not Applicable, TBD=To be determined after interim goal is achieved

Other measurable objectives: Hydro operation recommendations in the form of Biological (2002) and integrated (2003) rule curves for Lake Roosevelt to help balance costs / benefits of reservoir operations to all stakeholders.

## **f. Methods**

The Lake Roosevelt Monitoring Program is attempting to complete numerous divergent, yet related tasks using monitoring, evaluation and research methodologies. Therefore, the following discussion may not adequately justify all methods used by this project or provide adequate linkages among the various objectives due to space limitations.

Two closely related objectives of this program are: i) monitor and evaluate impacts of hatchery origin fish on wild fish and lower trophic levels within Lake Roosevelt ecosystem; and ii) monitor and evaluate the performance of hatchery fish in the Lake

Roosevelt fishery. Creel surveys, standardized fishery surveys and mark recapture analyses are major tasks associated with these objectives.

The creel survey is a two-stage probability sampling scheme used to determine annual fishing pressure, catch-per-unit-effort and sport fish catch and harvest by species in Lake Roosevelt. This survey was designed according to methods described by Lambou (1961 and 1966) and Malvestuto (1983). From 1988 to 1998 the surveys were conducted by three creel clerks at access points approximately 21 days a month, 12 months a year. In 1999, 9 months out of the year will be surveyed to reduce costs. The creel is used to estimate the numbers of wild and hatchery origin fish harvested, identify temporal and spatial overlap of wild and hatchery fish, and growth and size of fish harvested. Creel surveys are instrumental in assessing hatchery performance and achievement of biological objectives.

The Monitoring Program has conducted fish surveys once in spring, summer and fall since 1988 to present. Standardized fish surveys consist of electrofishing, gill netting (vertical and horizontal) and beach seining (Cichosz et al. 1998). Meristic measures, bony structures and stomach contents are collected to monitor growth, age structure and food preference. This information is further expanded to monitor potential competitive interactions among wild and hatchery origin fish based on changes in growth, age structure and diet overlap.

Mark-recapture studies have played a key role in monitoring and evaluating hatchery fish performance since 1988. Approximately 20,000 net pen rainbow trout are made with anchor tags annually and released. Tagged fish are recovered through creel surveys, fish surveys and voluntary angler returns. Tagging studies provide information on performance of hatchery reared fish in the fishery, growth rates, dispersion from release sites and an index of entrainment. This information is then related to hydro-operations.

Mark and recapture methods are also used to assess the program goal of establishing, monitoring and evaluating a self-sustaining Lake Roosevelt kokanee egg supply. Up to 500,000 kokanee yearlings are coded wire tagged by this program annually, subjected to chemical imprinting (Scholz et al. 1993, Tilson et al. 1993 and 1994), and released at various locations throughout the reservoir. Coded wire tagged kokanee recapture information is analyzed in the same manner as rainbow trout data. Tagged fish are recovered by extensive electrofishing and trapping surveys during the spawning migration to determine which release groups are most successful at returning to egg collection facilities.

In 1997, we enhanced existing methods and increased sampling periodicity and intensity to provide data necessary for ecosystem modeling. Water quality data were collected from the photic and aphotic zones using a hydrolab and water grabs analyzed by the Spokane Tribal laboratory. Water grabs consisted of composite samples collected from each zone twice per month. Laboratory analysis provided baseline information for commonly accepted analytes associated with limnological studies (i.e. phosphorous, nitrogen and metals). Chlorophyll *a* concentrations and phytoplankton speciation and

bio-volume are also collected as part of bi-weekly water quality monitoring. Primary productivity is then related to water quality under the context of hydro-operation and other overriding variables. Furthermore, the design of this study is to allow simple measures (i.e. secchi disk) to become the means of monitoring complex system responses (i.e. changes in phytoplankton abundance) in the future.

To achieve an instantaneous estimates for phytoplankton growth, carbon 14 studies are conducted seasonally at select sites. This information will be used in the modeling process to define water quality influences on phytoplankton growth in Lake Roosevelt. Since carbon 14 data has been previously collected by various studies on Lake Roosevelt, this method provides a continuous data set to assess long term variations in system productivity.

Zooplankton are collected twice per month at each of eleven standardized monitoring stations. Zooplankton are collected using a Wisconsin net, and triplicate tows will be made from a depth of 33 m to the surface. Zooplankton will be identified and enumerated to estimate biomass, production rates, and effects of hydro-operations on the population dynamics. Zooplankton and phytoplankton data will be utilized in bioenergetics models to define ties between hydro-operations and fish production (based on available primary and secondary production information) in Lake Roosevelt.

In 1997 and 1998 an additional method was employed to study zooplankton population dynamics. An in situ zooplankton corral was placed at three sites along the length of the reservoir. These corrals were deep enough to allow diel vertical migrations with a mesh size large enough to allow phytoplankton to move freely in and out of the corral, but small enough to contain most zooplankton species. The reason for the study was to obtain two pieces of information. The first is to determine what effect hydro-operations have on the zooplankton population and the second is how do zooplankton perform in the absence of zooplanktivorous fish. The corrals also allow researchers to track individual population cohorts which is nearly impossible in an ambient lake setting. This method will give us an understanding of zooplankton production potential and realized population growth rates. As with phytoplankton, numerous analysis are undertaken to find relationships among trophic levels and physio-chemical lake characters. Most kokanee enhanced lakes now contain mysid shrimp which further complicates kokanee management. Thankfully, mysids have not been found in Lake Roosevelt.

Benthic macroinvertebrates have been sampled by a number of previous studies, including Bortleson et al. 1994, Griffith et al (1995) and Griffith and Mac Dowel (1996). These and other Lake Roosevelt studies used nine index stations with elevation stratafications. This study continues tracking the benthic macroinvertebrate population by use of a ponar dredge. We attempted to replicate previous studies by sampling at sites established in previous studies. Macroinvertebrate density is important component when using bio-energetic models and considering methods to enhance the complexity of the ecosystem.

Habitat use and availability studies commenced in 1997. These studies began by mapping habitat types at nine index sites broken into embayment, shear wall and other categories. These sites are also examined during drawdown periods (de-watered) to measure substrate type, lake bottom slope, and structure. Once re-watered, fish surveys are conducted over habitat units at various times of the year. Collected information is used to determine habitat use. At the same time, a GIS bathymetric map with overlays of habitat characteristics is being developed to estimate the availability of habitat throughout the reservoir. The GIS map will be able to predict the availability of habitat or the lack thereof with each incremental foot of drawdown.

The Monitoring Program has had limited success in collecting kokanee in littoral habitats. In 1997, mobile hydroacoustics were deployed in Lake Roosevelt as a means to obtain distribution and population estimates of the mid-lake kokanee. The use of hydroacoustics will allow us to track kokanee populations, identify periods when kokanee are vulnerable to entainment, study fish disbursal behavior on recently released hatchery kokanee and observe changes in kokanee locations with changes to hydro-operations. This information in conjunction with the fixed hydroacoustics data collected at Grand Coulee Dam by the Chief Joseph Kokanee Enhancement project will provide the opportunity to make hydro-operation recommendations which minimize entainment. Entrainment is currently believed to be the main factor limiting kokanee abundance in lake Roosevelt.

All of the information collected by this project will be synthesized into specific relationships by which models can predict the effect of various changes to the system on the trophic levels of Lake Roosevelt. CE-Qual is being prepared to model water quality through zooplankton. The Wisconsin Bioenergetics Model is currently being set up to predict the effect of target species on the environment and food web. The GIS model will provide the littoral response. Hydrosim or a compatible variation of that model will predict lake elevations and water retention times for a 60 year record on a weekly time step. Finally an umbrella model is scheduled to be created which links and provides feedback loops among the various models.

The model shall be used to predict the effect of various hydro-operation and management scenarios on the fishery and ecosystem of the lake. These model results will inform and provide a bases for the development of a Lake Fisheries Management Plan which provides hydro-operation recommendation (integrated rule curves) and management actions (habitat restoration activities, hatchery fish stocking, harvest management). The management plan will be a product of regional Columbia basin Stakeholders. Recommendations will have consider constraints of economic, social and biological character and have had regional acceptance prior to implementation.

#### **g. Facilities and equipment**

Office and laboratory space used by the Lake Roosevelt Monitoring Program (LRMP) are located within the Spokane Tribal Natural Resources Building in Wellpinit, WA. Storage space for boats, equipment and supplies is available at two locations on the Spokane

Reservation; a 36x40' metal building located adjacent to the natural resources building, and a storage facility located near Little Falls Dam.

Three vehicles are owned and/or utilized by the LRMP; a 1 ton Dodge pickup (dually) equipped with electric brakes, a 3/4 ton Ford pickup equipped with a snowplow, and a 1/2 ton Chevy pickup. The LRMP also utilizes a 33' Bounder motor home to house employees during extended field efforts.

The LRMP owns and/or uses four boats; a 15' fiberglass Boston Whaler with a 90 hp outboard engine, a 19' Bildwel aluminum boat with 135 and 9.9 hp outboard engines, a 21' Smith Root electrofishing boat with a 200 hp outboard engine, and a 21' Smith Root electrofishing boat with an inboard engine and jet drive. All boats are equipped with individual trailers and can be effectively towed with the vehicles currently available to the LRMP.

Computer systems currently in use by the LRMP include 2 Power Macintosh systems, one Macintosh Quadra 650, and a Macintosh PowerBook, two Pentium PC's, and a network equipped PC to serve as a network hub within the LRMP.

The LRMP currently has all necessary field equipment to conduct the sampling described in this proposal. Equipment which is subject to high use and wear (i.e. gillnets) are repaired when appropriate and replaced as necessary.

#### **h. Budget**

The line item Personnel, Fringe Benefits, Supplies, Operation and Maintenance and Travel are self-explanatory.

Capital equipment will include the purchase of a Hydrolab to facilitate water quality data collection.

Washington Department of Fish and Wildlife will continue to conduct hydroacoustic surveys, and refine Wisconsin Bioenergetics model.

Colville Confederated Tribes will continue to conduct net pen nutrient studies, habitat inventory and utilization, and macroinvertebrate surveys.

Spokane Tribal Laboratory will process water samples to identify the concentration of common nutrient and metal analytes.

University of Portland – Dr. Wells will continue to refine the model CE-Qual, develop a refined hydrosim model and assist with the development of an umbrella model.

Eastern Washington University – Dr. Scholz will continue to assist with the indexing of walleye during spawning period, collect mark kokanee during spawning, extract tags and analyze return group success.

Eastern Washington University – Dr. Soltero will continue to enumerate phytoplankton by taxon and determine chlorophyll *a* concentrations in water samples.

Washington State University – Dr. Funk will continue to a lesser degree to estimate primary productivity with carbon 14 methods.

## **Section 9. Key personnel**

<b>Name</b>	<b>Position</b>	<b>Primary Duties</b>
Keith D. Underwood	Program Manager	Overall program oversight and direction; Contractual and financial obligations, Coordination with other management entities; Sub-contract oversight; Research planning and design.
Thomas A. Cichosz	Fisheries Biologist II	Oversight of day to day program operations including office, laboratory, and field activities; Research planning and design; Data analysis and report writing.

**KEITH UNDERWOOD, M.S.**  
**Project Manager**

*EDUCATION*

M.S. Biology, Eastern Washington University, 1996  
B.S. Biology, Eastern Washington University, 1992

*EXPERIENCE*

**Project Manager**--Spokane Tribe of Indians, Wellpinit, WA., January 1994 to present.

Project Manager of the Lake Roosevelt Monitoring Program oversees administrative, planning, design, research and coordination activities. The program is collecting data and modeling the physical and biological attributes of the lake. The completed model will be used in the development of a fisheries management plan recommending a suite of hydro operations and management actions.

**Project Biologist**--Spokane Tribe of Indians, Wellpinit, WA. January 1994 to January 1993.

Collected and analyzed data on water bodies contained within the Spokane Tribal Reservation for fisheries management planning. Assisted the Lake Roosevelt Monitoring Program with data collection. Participate in regional forums that coordinate fisheries management actions in the Columbia River.

**Research Assistant II**--Eastern Washington University, Cheney, WA., April 1992 to December 1992.

Collected and analyzed population indices, diet, and microhabitat use of bull trout, chinook salmon and rainbow trout in three streams of southeast Washington to identify whether bull trout populations are negatively impacted from stocking of hatchery reared chinook salmon and rainbow trout. Also conducted spawning ground surveys by foot and migration behavior by radiotelemetry to better understand bull trout behavior.

**Research Assistant I**--Eastern Washington University, Cheney, WA. April 1991 to March 1992.

Conducted backpack electrofishing surveys on three southeast Washington streams to estimate fish population density and collect diet information. Enumerated macroinvertebrates from Hess samples.

*PUBLICATIONS*

Author of masters thesis and five professional reports; including lead author of 1993 through 1995 and co-author of 1996 and 1997 annual reports for Lake Roosevelt Monitoring Program.

*PROFESSIONAL PRESENTATIONS*

Two professional presentations in past year, as well as numerous informal presentations.

*PROFESSIONAL SOCIETIES*

American Fisheries Society since 1991.  
North American Lake Management since 1995.

**THOMAS A. CICHOSZ, M.S.**  
**Fisheries Biologist II**

**EDUCATION**

M.S. Fisheries Resources, University of Idaho-Moscow, 1996

B.S. Water Resources/Biology, University of Wisconsin-Stevens Point, 1989

**EXPERIENCE**

**Fisheries Biologist II**--Spokane Tribe of Indians, Wellpinit, Washington. January 1997 to present.

Project biologist responsible for planning, design, coordination and execution of research and management surveys on Lake Roosevelt, Washington. Surveys relate to fisheries, limnology, and zooplankton and are directed toward both current management and future modeling efforts within the Lake Roosevelt ecosystem. Other responsibilities include data analysis and report writing, oversight and assessment of work completed by subcontractors, and scheduling of personnel and equipment resources.

**Data Analyst**--University of Idaho-Moscow. November 1996 to January 1997.

Used multivariate analyses to assess habitat use by juvenile chinook salmon in Lower Granite Reservoir. Included extensive use of SAS and other statistical software to perform canonical correspondence and discriminant analyses. Other responsibilities included report writing and assisting graduate students with SAS programming and data analysis.

**Graduate Research Assistant**--University of Idaho-Moscow. August 1994 to October 1996.

Performed extensive computer modeling of northern pike minnow population dynamics using SAS statistical software. Also participated in studies examining predation of salmonids by smallmouth bass and diet composition of fishes in Lower Granite Reservoir. Conducted fishery surveys by electrofishing, gillnetting and beachseining.

**Fisheries Bio-aide**--Idaho Department of Fish and Game, Coeur d'Alene, Idaho. April 1994 to August 1994.

Captured white sturgeon and burbot and assisted in implantation of radio and sonic transmitters. Performed radio and sonic telemetry in lake and riverine setting. Collected sturgeon eggs to monitor spawn timing and success. Conducted backpack electrofishing surveys of Kootenai River tributaries.

**Environmental Specialist**, Ecology Department--Environmental Science & Engineering, Inc., St. Louis, Missouri. May 1990 to April 1994.

Four years of professional responsibility including training and supervision of temporary employees, and project budget and timeline oversight. Collected adult and larval fish, mussels, and macroinvertebrates. Also responsible for taxonomy of adult fish and benthic macroinvertebrates, various data operations and report writing.

**RECENT PUBLICATIONS**

Author of masters thesis and seven professional reports; including lead author of 1996 and 1997 annual reports for Lake Roosevelt Monitoring / Data Collection Program.

Cichosz, T.A. 1996. Factors affecting the abundance of northern squawfish in Lower Granite Reservoir. Masters Thesis. University of Idaho, Moscow.

Cichosz, T.A., J.P. Shields, and K.D. Underwood. 1997. Lake Roosevelt fisheries and limnological research. 1996 Annual Report. Bonneville Power Administration, Portland, Oregon.

Bennett, D.H., S. Anglea, S.R. Chipps, T.A. Cichosz, M. Davis, T.J. Dresser, Jr., and M.A. Madsen. In progress. Interactions and factors affecting abundance of selected fishes in Lower Granite Reservoir, Snake River. Completion Report. U.S. Army Corps of Engineers, Walla Walla, Washington.

Anonymous co-author. 1995. 1993 Ohio River ecological research program. Final report by ESE, Inc. to American Electric Power Service Corporation, Ohio Edison Company, and Ohio Valley Electric Corporation.

Anonymous co-author. 1994. The upper Illinois waterway study, 1993 benthic macroinvertebrate investigation and habitat assessment, RM 272.0-323.0. Interim report by ESE, Inc. to Commonwealth Edison Company, Chicago.

## **Section 10. Information/technology transfer**

All project information and data will be made available through annual reports submitted to BPA. In addition, ecosystem models developed under Objective 1 (Section 3) will be made available to the public and any interested agencies upon completion.

The project staff regularly attends workshops and conferences concerning relevant issues and presents project direction, findings, and implications within a professional forum.

**Congratulations!**